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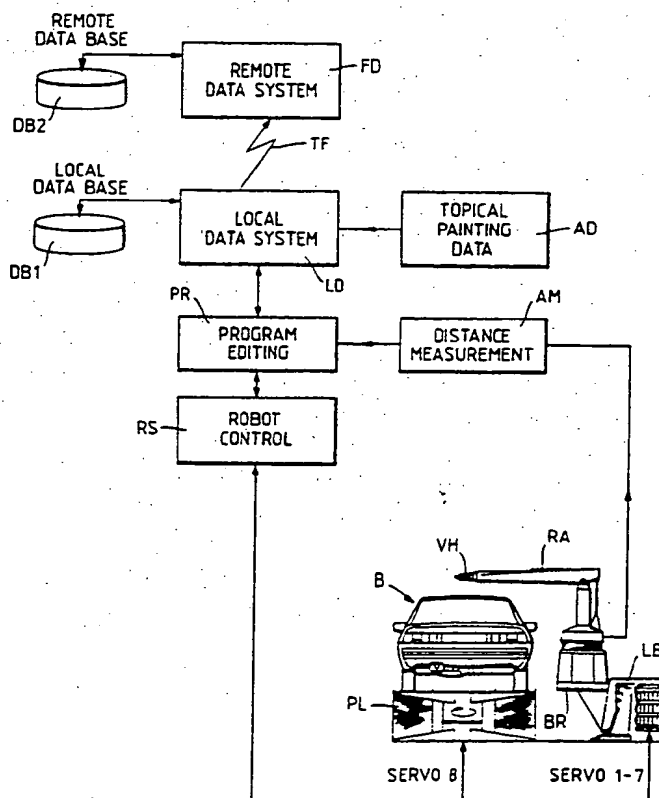


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(21) International Application Number: PCT/NO89/00003 (22) International Filing Date: 4 January 1989 (04.01.89) (31) Priority Application Number: 880016 (32) Priority Date: 5 January 1988 (05.01.88) (33) Priority Country: NO (71) Applicant (for all designated States except US): ABB TRALLFA ROBOT A/S [NO/NO]; P.O. Box 265, N-4341 Bryne (NO). (72) Inventors; and (75) Inventors/Applicants (for US only) : HETLAND, Amund [NO/NO]; N-4063 Voll (NO). KJOSAVIK, Dag [NO/NO]; Olabakken 37, N-4300 Sandnes (NO). (74) Agent: J.K. THORSENS PATENTBUREAU A/S; P.O. Box 2584 Solli, N-0203 Oslo 2 (NO).		(81) Designated States: AT (European patent), BE (European patent), CH (European patent), DE (European patent), DK, FI, FR (European patent), GB (European patent), IT (European patent), LU (European patent), NL (European patent), NO, SE (European patent), US. Published <i>With international search report.</i>

(54) Title: METHOD AND ROBOT SYSTEM FOR REPAIR PAINTING OF MOTORCARS**(57) Abstract**

A method and a mobile servo-operated robot system (VH, RA, LB, PL) for repair painting of motorcars utilize an associated computer system (LD) for the guiding of painting tools in accordance with preprogrammed operational data which are stored in one or more data bases. Topical data (AD) describing the repair painting to be performed, e.g. type of car, year model, colour code and painting area, are supplied to the associated computer system (LD), which then is actuated to search for corresponding operational data in its own data base (DB1) and/or possibly other, remotely connected data bases (DB2). The preprogrammed operational data provided in this way are then selected for the required control of the robot system (VH, RA, LB, PL) when performing the intended painting operation. The computer system (LD) is suitably connected to means (DR) for modifying program editing of the selected operational data in accordance with special prevailing conditions. A graphic screen for displaying the painting area together with the painting program may be used for this purpose.



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Method and Robot System for Repair Painting of Motorcars.

The present invention is related to a method and a mobile servo-operated robot system for repair painting of motorcars, an associated computer system being utilized for guiding a painting tool in accordance with programmed operational data stored in one or more data bases.

Robot systems are to a great extent used for the painting of motorcars in serial and mass production, in which the same preprogrammed operational data are utilized for the painting of each car belonging to the same production series. With repair painting due to damage or with repainting of cars, however, it has up to now not been practical or possible to utilize painting robots with all their advantages, as the painting operation evidently would be different in each case and the programming of new operational data for each repair painting would be time and work consuming.

Thus, it is an object of the present invention to provide a method and a robot system with associated computer means, which suitably may be utilized for repair painting without necessarily performing a new programming for each painting operation.

The invention then concerns a method for repair painting of motorcars by means of a mobile, servo-operated robot system with an associated computer system for controlled guiding of painting tools in accordance with preprogrammed operational data which are stored in one or more data bases.

The unique features of this method according to the invention are that topical descriptive data related to the repair painting in question, e.g. type of car, year model, colour code and painting area, are supplied to said associated computer system, which then is actuated to search for corresponding operational data in its own data base and/or possibly in other remotely connected data bases, the preprogrammed operational

data provided in this way being selected for the control of the robot system when performing the required repair painting, possibly subsequent to a modifying program editing in view of the prevailing operative conditions.

Prior to the initiation of the painting operation the robot system is preferably actuated to gauge the position of the area to be painted relative to said system, as a basis for said modifying program editing.

In order to facilitate said search of the computer system for preprogrammed operational data in the data bases, such data may suitably be programmed in the form of data modules, each module corresponding to an individually associated painting area on the type of motorcar in question.

The invention also comprises a movable servo-operated robot system for repair painting of motorcars and comprising an associated computer system operatively adapted for controlled guiding of painting tools in accordance with preprogrammed operational data, which are stored in one or more data bases. According to the invention the unique features of this robot system then reside in the facts that said computer system further is operatively adapted, in response to supplied topical data describing the repair painting to be performed, e.g. type of car, year model, colour code and painting area, to search for corresponding operational data in its own data base and/or possibly in other, remotely connected data bases and to select the preprogrammed operational data provided in this way for controlling the robot system when performing said repair painting.

For the performance of such repair painting the robot system suitably comprises in practice a robot arm having seven axes of motion for guiding the painting tools, and a platform having an eighth axis of motion for manipulating the motorcar which is to be painted.

The invention will now be described in more detail by means of an exemplified embodiment with reference to the accompanying drawings, on which:

- Fig. 1 shows in plan view a robot system according to the invention with a car disposed for repair painting, and
- Fig. 2 shows in elevation the robot system in Fig. 1 with the components of the computer system and the robot control schematically illustrated.

Fig. 1 illustrates in plan view a mobile servo system comprising a robot arm RA on a carrier BR, which is movable along a linear path of motion LB. The robot arm carries at its extreme end a tool socket VH, which is pivotable about three mutually orthogonal axes relative to the robot arm. The robot arm is in turn disposed for pivotal movements about three axes relative to the carrier BR, these three axes being also mutually orthogonal. The robot arm on its carrier is suitably disposed for movements along its linear path of motion in the vicinity of a pivotable platform PL for a car, which is to be repair painted and is shown in two pivotal positions, B and B' respectively. Thus, the robot system comprises totally eight axes of motion, of which six are associated with the robot arm RA itself and its tool socket VH, one is utilized for displacement of the arm carrier BR along the linear path of motion in the vicinity of the car, and the eighth axis is used for pivoting the car in the horizontal plane to bring the car to an appropriate position relative to the robot system.

In Fig. 2 the robot system of Fig. 1 is shown together with the car B to be repair painted, the robot control and the associated computer system being shown schematically with their functional connections. The robot control and the local data computer means are not included in the present invention and may be of any suitable type, e.g. as described in Norwegian Patent Specification No. 131.906. At all times the robot control takes care of the servo regulation of the robot system in accordance with the data program which is present in the

local computer system.

With conventional applications of painting robots the painting program is fixed and unchanged for a great number of identical painting operations, as it is the case with serial production of motorcars.

With repair painting according to the present invention it is, however, necessary to find a new and suitable painting program in each single case, and for this purpose relevant painting data for the case in question is fed into the associated local data system LD. These painting data AD then indicates primarily the extension and location on the car of the area to be painted, but also the make and year model of the car and the appropriate colour code. The computer system LD then tries to find correspondingly programmed operational data in its local data base DB1, in which a number of painting programs for various makes of cars are stored. If it is not possible to find the desired operational data in this data base, the computer system LD will by means of telephone connections search for the required operational data in the data bases of other, remote data systems FD. The various major motor car producers may have e.g. painting data for all their car types and models stored in a particular data base for painting programs.

When the local computer system LD has found appropriate operational data, either in the associated data base DB1 or in one or more remote data bases DB2, these operational data are selected as a basis for the repair painting to be carried out, and are stored in a suitable data register in the local system until the painting process is initiated. A final program editing PR may suitably take place before the selected programmed data are supplied to the robot control RS. A graphic screen may then be used for displaying the painting area and its spraying paths. With this editing also the position of the car and the painting area in relation to the robot system is taken into account, on the basis of distance

measurements performed by the robot arm of the system. Subsequent to the program editing the edited and selected painting program is transferred to the robot control RS, which takes care of the appropriate guiding of the painting tool by means of the various servo-mechanisms 1 - 7, 8, which are provided for the regulation of the movements of the robot system with respect to its different axes of motion.

During the search performed by the computer system for programmed operational painting data, the car and the painting area may be prepared for the painting process (cleaning, spackling, grinding etc.) The robot system may also suitably be used for additional tasks in connection with the painting proper, e.g. drying by means of infrared or ultraviolet light. In such cases the robot would manipulate other tools than a painting tool, and automatic change of tools may possibly be included in the painting program.

With utilization of the technically advanced painting robots which now are available, also for repair painting, many operational advantages are achieved, e.g. rapid, optimum and automatic use of all the painting information which is stored in the various data bases, as well as relieving human workers from work in a painting environment which is injurious to health.

PATENT CLAIMS:

1. Method for repair painting of motorcars (B, B') by means of a mobile, servo-operated robot system (VH, RA, LB, PL) with an associated computer system (LD) for controlled guiding of painting tools in accordance with preprogrammed operational data which are stored in one or more data bases, characterized in that topical descriptive data (AD) related to the repair painting in question, e.g. type of car, year model, colour code and painting area, are supplied to said associated computer system (LD), which then is actuated to search for corresponding operational data in its own data base (DB1) and/or possibly in other remotely connected data bases (DB2), the preprogrammed operational data provided in this way being selected for the control of the robot system (VH, RA, LB, PL) when performing the required repair painting, possibly subsequent to a modifying program editing (PR) in view of the prevailing operative conditions.
2. Method as claimed in claim 1, characterized in that the robot system is actuated to gauge the position of the area to be painted relative to said system, as a basis for said modifying program editing.
3. Method as claimed in claims 1 or 2, characterized in that the preprogrammed operational data are programmed in the form of data modules, each such module corresponding to an individually associated painting area on the type of car in question, in order to facilitate said data search of the computer system.
4. Mobile servo-operated robot system (VH, RA, LB, PL) for repair painting of motorcars (B, B') and comprising an associated computer system (LD) operatively adapted for controlled guiding of painting tools in accordance with preprogrammed operational data, which are stored in one or more data bases, characterized in that said computer system (LD)

further is operatively adapted, in response to supplied topical data (AD) describing the repair painting to be performed, e.g. type of car, year model, colour code and painting area, to search for corresponding operational data in its own data base (DB1) and/or possibly in other, remotely connected data bases (DB2) and to select the preprogrammed operational data provided in this way for controlling the robot system when performing said repair painting.

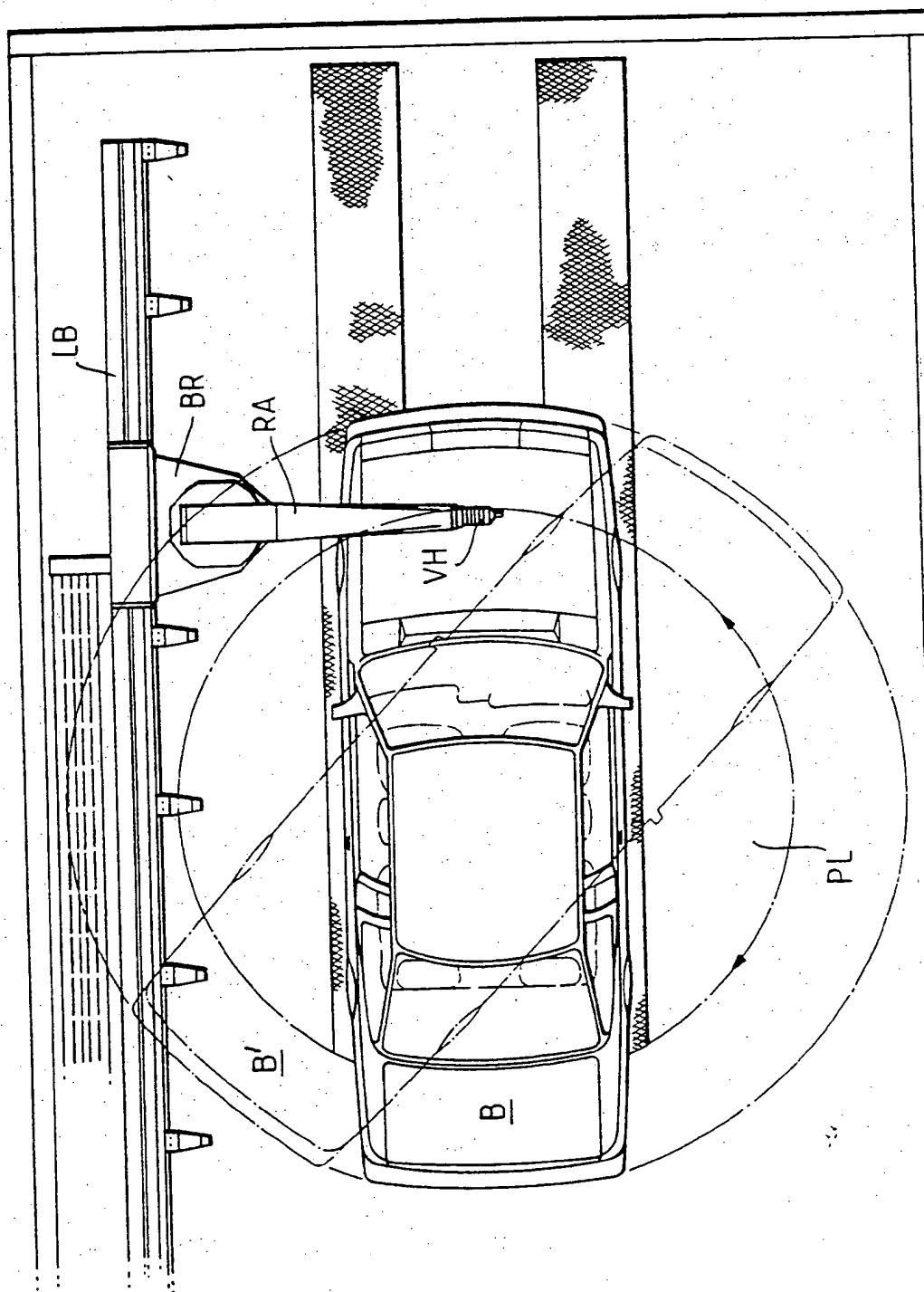
5. Robot systems as claimed in claim 4, characterized in that the computer system (LD) is connected to means (PR) for modifying editing the selected operational data in agreement with special prevailing conditions, e.g. by means of a graphic screen for displaying the painting area and its painting program.

6. Robot system as claimed in claim 4 or 5, characterized in that it is operationally adapted for gauging the position of the area to be painted relative to said system, possibly as a basis for said modifying program editing.

7. Robot system as claimed in claims 4 - 6, characterized in that it comprises a guiding system (VH, RA, LB) having seven axes of motion for guiding the painting tools, and a platform (PL) having an eighth axis of motion for manipulating the motorcar which is to be painted.

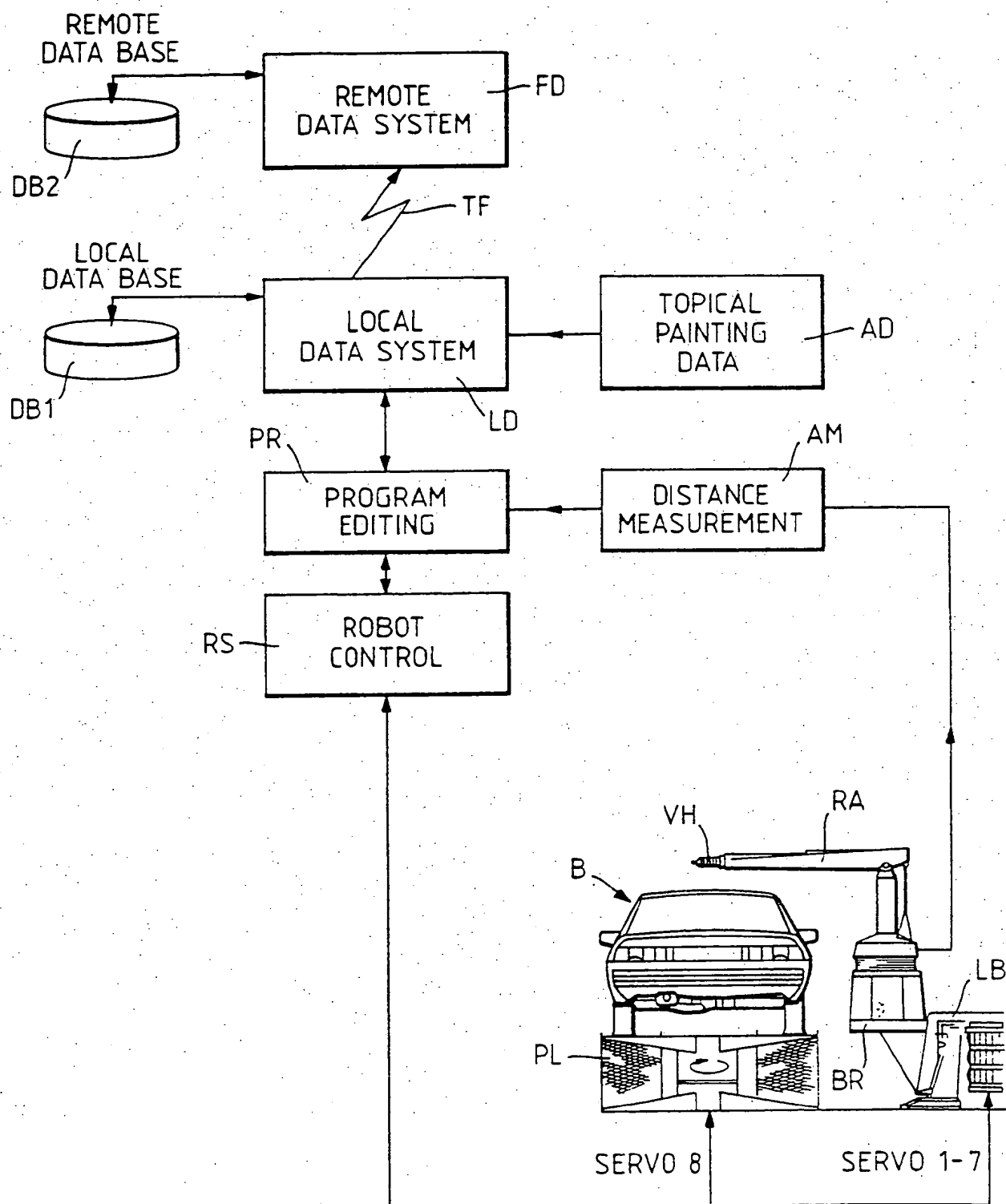
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Fig. 1.



2/2

Fig. 2.



INTERNATIONAL SEARCH REPORT

International Application No PCT/N089/00003

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) * According to International Patent Classification (IPC) or to both National Classification and IPC 4		
B 25 J 9/18, B 05 B 13/04		
II. FIELDS SEARCHED		
Minimum Documentation Searched 7		
Classification System	Classification Symbols	
IPC 4	B 05 B 13/02, /04, 15/10; B 25 J 9/00, /16, /18, 11/00; G 05 B 19/403, /41, /42	
US C1	118:314, 319, 323, 668-687, 695-698, 707; 364:513: 427:421, 424	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched 8		
SE, NO, DK, FI classes as above		
III. DOCUMENTS CONSIDERED TO BE RELEVANT 9		
Category *	Citation of Document, 11 with indication, where appropriate, of the relevant passages 12	Relevant to Claim No. 13
Y	ASEA Journal, No. 5, issued 1987, Dag Kjosavik and Björn M. Apeland, "Coating systems for the automotive industry.", page 8-9.	4, 7
Y	EP, A3, 0 084 523 (BASFER S.P.A.) 27 July 1983 See figure 1.	7
Y	DE, A1, 3 102 779 (CHAMPION SPARK PLUG CO.) 17 December 1981 See claim 1. & FR, 2476507 JP, 56126462 GB, 2070281	1
Y	US, A3, 4 714 044 (KIKUCHI ET AL) 22 December 1987 See column 2, line 46 - column 6, line 14, figures 4-8. & GB, 2177946 JP, 62004464	1, 4
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* Special categories of cited documents: 10 "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art. "&" document member of the same patent family		
IV. CERTIFICATION		
Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report	
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III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
Y	EP, A3, 0 249 171 (BEHR-INDUSTRIEANLAGEN GMBH & CO) 16 December 1987 See column 3, line 22 - column 4, line 28. & DE, 3619429	1, 4
Y	EP, A1, 0 192 338 (HADEN DRYSYS INTERNATIONAL LTD) 27 August 1986 See page 12, lines 10-15, figure 1. & JP, 61204060	1, 7

